wealth. As regards the real wealth of the world, its matter and its energy, as man had found it so, largely, had he left it, until the beginning of last century. Eternally moralising and philosophising about himself, he left little behind him but a vast legacy of morbid introspection for the "education" of his children. Ignorant of the simplest principles which control absolutely his life from the cradle to the grave, he strove to entail upon his successors in perpetuity the conclusions of his preposterous self-examinations. The time had come when, as the result of a disastrous war, this entail had been broken. Henceforth it would be known that science had in its control the major physical factors of human existence. Already the attempt had been made to foist upon science the responsibility of the war. But science was neither the destroyer nor the upbuilder; it was the docile slave of its human masters. The use made of it depended upon whether they were awake to their position with regard to the external realities of nature, or whether they were still trying to compromise with the old mixed mythologies. After the war, whatever its outcome, science and its application could retrieve every disaster, and make good even the present seemingly irreparable destruction.

A change had come over the relations of man to matter and energy. No longer between these two, as between a steam-hammer and an anvil, he now had a hand on the valve. And if they examined the hand they would find that it was the hand of the chemist.

Just as the control of money was put into the hands of a properly authenticated banker, let them see to the hand in the control of their wealth. Let it not be the hand of the lawyer-politician, or of a hypnotised dreamer "born in the menagerie," as Mr. H. G. Wells had expressed it, whose intellectual faculties were in thrall to the past, nor even of the medical man, as, now too long, the exclusive public representative of science. Let it be in the hands of honest and well-trained chemists and similar representatives of the other physical sciences, and they would be surprised what unimagined wealth was rolling by unheeded, as Niagara used to do, but rarely as picturesquely and inoffensively. Let them not be frightened by those who would have them believe that science—the knowledge and control of the world outside and independent of themselves—was a monstrous materialism. Such people merely disclosed their ignorance of science, and all that it meant for humanity.

A chemist if he were genuine was rarely worldly-wise. To him secrecy and individualism were the antithesis of the spirit of science. He might be able to put on half a sheet of notepaper that which would keep a whole class in the community in prosperity for a generation. But he would be lucky if until the end he kept out of the poor-house, and still more lucky if in his old age he could still call any of his discoveries his own. But the real discovering type of chemist was a very rare bird, and it was scarcely necessary to say he was not the type specially catered for by university curricula. From a business point of view he was a thoroughly bad investment. He paid no more fees than his numerous fellows, his training was preposterously expensive, if he was to know his subject and not know about it, and, worst of all, when he was hatched, no one could be sure whether he was a swan or a goose. Obviously with universities, financially managed by business men, the good staple lines of chemical students are far more attractive. They can be turned out in large numbers relatively cheaply, their fees aggregate to a considerable sum and bear an appreciable proportion to the cost of their education, and their numbers speak for themselves.

But a chemist, gauging the relative chemical value to the nation of all this teaching, would rate it in the inverse ratio to that in which it would be regarded if numbers or revenue accruing to the university were the criterion. You need the small army of professionally trained students to keep the existing machine going. But a machine that just keeps its own cumbrous self going has no right to the title of a prime-mover. As much and more do you need the pioneers, those who are to stand erect for the first time and know their way, where all before have been befogged, in whose solitary footsteps the army *can follow.* A university that does not give of the best it can afford for these is oblivious to the more difficult and more repaying side of its dual function.

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## HIGH EXPLOSIVES AND THE CENTRAL NERVOUS SYSTEM.

MAJOR F. W. MOTT, who recently delivered the Lettsomian Lectures[1] to the Medical Society of London upon "The Effects of High Explosives on the Central Nervous System," pointed out that a new epoch in the medical history of war had arisen in consequence of trench warfare and the employment of projectiles containing large quantities of high explosives. In particular, he discussed the causation of death without visible injury, resulting from the detonation of large quantities of high explosives, *e.g.* trinitrotoluene contained in shells, as well as other projectiles, and mines. The central nervous system contained in the closed cranio-spinal cavity is suspended in a water-jacket of cerebro-spinal fluid, which, under ordinary conditions of shock, effectually protects the delicate nervous structures from commotion; and the large quantity of this fluid at the base of the skull serves particularly as a water-cushion protecting the vital centres of the medulla oblongata from the effects of concussion.

Major Mott discussed the possibility of the aerial force generated by detonation of 50–200 lb. of trinitrotoluene being so great as to be transmitted through the fluid to these vital centres, and cause death by instant arrest of the cardiac and respiratory centres. Considerable attention was given to the observations of a French civil engineer, M. Arnoux, who found that the effects of the explosion of a large shell upon an aneroid barometer were such that decompression experiments to produce similar effects on the barometer indicated that a pressure of 10,000 kilos per square metre must have been generated by the explosion. M. Arnoux inferred from this that the bursting of a large shell might cause such an intense atmospheric decompression as to liberate enough bubbles of air and $CO_2$ in the blood to prove fatal by the blocking of multiple small vessels (embolism). In support of this hypothesis, it was pointed out that multiple embolism is the cause of Caisson disease. Lord Sydenham expressed the opinion to Major Mott that the explosive force might cause death by the sudden pressure on the thorax and abdomen, arresting the action of the heart and lungs.

The possibility was also discussed of the production of noxious gases, *e.g.* CO, which would deoxygenate the blood by combining with the hæmoglobin, and thus cause the sudden death of groups of men who have been found in trenches and closed spaces without visible signs of injury and in the last attitude of life. In explanation thereof, he suggested that the muscles of fatigued men suddenly poisoned by inhalation of carbon monoxide in large quantities might pass rapidly into *rigor mortis*. In support of this hypothesis it may be mentioned that Major Mott received through Lord Sydenham information from the secretary of the War Trench Committee to the effect that imperfect detonation of 50–100 lb. of trinitrotoluene would produce sufficient carbon monoxide to cause poisoning.

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[1] The Lettsomian Lectures on "The Effects of High Explosives upon the Central Nervous System," delivered before the Medical Society of London by Dr. Fred W. Mott, F.R.S., Major, R.A.M.C. (T.), 4th London General Hospital. *Lancet*, February 12, 26, March 11, 1916.

In support of the opinion that carbon monoxide poisoning may account for some of the symptoms and the fatal termination of cases of "shell shock with burial," and without visible external energy, Major Mott showed photographs and photomicrographs of the brains of cases of carbon monoxide poisoning, and demonstrated the fact that the punctate multiple hæmorrhages found throughout the white matter of the brain corresponded with the appearances presented by the brain of a soldier who had been buried by the explosion of a shell. How long he had been buried was not known, as he was brought in comatose to the field ambulance station and remained so until death forty-eight hours later. Throughout this brain, especially in the white matter (as the photographs and photomicrographs demonstrated), there were multiple punctate hæmorrhages. There was no visible external injury to account for this condition of the brain, but, of course, it might have been the result of concussion by a sandbag; the lecturer adduced reasons against this assumption, and said the question whether carbon monoxide poisoning was a factor in the production of severe symptoms and fatal termination in "shell shock" could only be settled by examination of the blood of these cases. The lecturer thought that this would be worth doing, for he had seen numerous instances of shell shock with burial showing no visible injury, in which there was a complete loss of recollection and recognition, and from which the patients only slowly recovered. He narrated similar cases of profound loss of memory occurring as a result of carbon monoxide poisoning previous to the war.

Interesting photomicrographs of the spinal cord of a man who lived forty-eight hours after shell shock with burial were shown. The man retained consciousness to the end, but was paralysed in all four extremities; the intercostal muscles were also paralysed. The man was evacuated five minutes after the shell burst; therefore there was no time for him to be poisoned by carbon monoxide. Examination of the spinal column showed no visible sign of injury, but there were most extraordinary changes in the fourth and fifth segments of the spinal cord—notably hæmorrhage in the grey matter, sieve-like vacuolation of the fibres of the posterior column, and of one antero-lateral column; another striking feature was enormous swelling of many of the axis cylinders. The phrenic nucleus which innervates the diaphragm was destroyed with the exception of some of the cells in the third segment; these exhibited chromatolysis indicative of exhaustion. Sudden death would have been the result if the lesion had been half an inch higher, as the whole "nucleus diaphragmaticus" would have been destroyed by the spinal concussion, and respiration would have instantly ceased. How the spinal concussion was effected could not be ascertained; it was most probably due to a sandbag hurled from the parapet, for this man was partially buried. Still, it is difficult even then to account for the limitation of the lesion to an inch of the spinal cord except by transmission of the force to the cerebro-spinal fluid in which the spinal cord is suspended. The changes in the spinal cord were exactly similar to those described by Col. Gordon Holmes [2] as a result of concussion of the spinal cord caused by bullet wounds of the spinal column without penetration of the enclosing membranes.

Regarding the sieve-like vacuolation of the myelin fibres, and the enormously swollen axis cylinders, unlike that produced by ordinary fracture dislocation, it is of interest to note the opinion of Prof. Leonard Hill, who, in a letter to the lecturer, suggested that the shock may have been so great as to kill the axoplasm, for "a water pressure of between 300 and 400 atmospheres kills all protoplasm (excepting deep-sea fishes). Water enters into the muscle and swells it and turns it opaque. There are curious fractures produced in the muscle fibre. The myelin of nerve fibres is broken up by the water entering into these. In the case of a high-velocity bullet striking the spine, it seems possible that the cerebro-spinal fluid beneath the struck part may be instantly compressed and act as a solid body transmitting the blow to the cord. There cannot be time for the fluid to be displaced. There is, anyway, a water-pressure limit beyond which protoplasmic activity is destroyed, and I imagine bullets must produce this pressure, but I very much doubt whether air waves produced by shell bursts can reach to such pressures as 300–400 atmospheres."

It is quite possible, therefore, that a sandbag hurled against the neck could cause spinal concussion similar to that of a bullet wound, but without producing visible injury.

Major Mott then directed attention to the fact that while a large number of these patients were of a neurotic or of a neuropathic disposition, yet the strongest nervous system would eventually break down under the stress of continuous exposure to shell fire and trench warfare.

The varying groups of signs and symptoms indicative of loss of function or disorder of functions of the central nervous system arising from exposure to forces generated by the detonation of high explosives are classed under the term "shell shock." In a larger number of cases, although exhibiting no visible injury, shell shock is accompanied by "burial." The signs and symptoms, with the exception of the profound effects on consciousness and memory, accord in the main with those of the two common types of functional neurosis—neurasthenia and hysteria.

From the point of view of compensation or pension the War Office authorities very properly regard "shell shock" as a definite injury, although there may be no visible sign of it. This fact is of considerable importance, for, as in the case of pension or compensation for traumatic neurasthenia under the Employers' Liability Act, the notion of never recovering may become a *fixed idea*. The detection of conscious fraud is not easy in many cases of "shell shock" in which recovery might reasonably have been expected, for it is difficult in many cases to differentiate malingering from a functional neurosis due to a fixed idea. The first point is to be sure of your diagnosis that the disease is altogether functional, and being satisfied thereof to avoid all forms of suggestion of the possibility of non-recovery. A very great difficulty in the complete investigation of these cases arises from the fact that few or no notes, as a general rule, accompany the patient; one has therefore to rely upon the statements made by the patient himself, or perchance by a comrade, if he has no recollection of the events that happened. Most of the cases of "shell shock," however, are able to give satisfactory information of the events that preceded the shock; they even tell you they can call to mind the sound of the shell coming and see it in the mind's eye before it exploded; then there is a blank in the memory of variable duration. In some of the more severe cases, especially where there has been burial or physical concussion by a stone or a sandbag, or by falling heavily on the ground after being blown up in the air, there is a more or less complete retrograde amnesia of variable length of time. In a case of simple "shell shock" it is impossible to say whether the patient was unconscious during the whole period of time of which he has lost all recollection of the events that happened, or whether during the whole or a part of the time he was conscious, but owing to the "commotio cerebri" the chain of perceptual experiences was not fixed.

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[2] "Spinal Injuries of Warfare." Being the Goulstonian Lectures delivered before the Royal College of Physicians of London by Lt.-Col. Gordon Holmes. *Brit. Med. Journal*, November 27, December 4 and 15, 1915.

In the majority of cases "shell shock" affects only the higher cortical centres; in severe cases the vital centres, as in apoplexy, alone continue to function, and the patient is in a dazed condition, and he may automatically perform complex sensori-motor purposive actions of which he has no recollection whatever. Several cases of this kind have come under notice, one of the most trustworthy being a history obtained from an officer. His company had dug themselves in in a wood; he went out into the road to see if a convoy was coming, when a large shell burst near him. It was about two o'clock in the morning and quite dark; about 4.30 a.m. it was quite light, and he found himself being helped off a horse by two women who came out of a farm-house. He had no recollection of anything that happened between the bursting of the shell and this incident.

The frequency with which these cases of shell shock suffer from terrifying dreams at night and in the half-waking state points to the conclusion that a psychic trauma is exercising a powerful influence on the mind by the thoughts reverting to the terrifying experiences they have gone through, and their continuous influence on the subconscious mind may account partially for the terrified or vacant look of depression on the face, the cold blue hands, feeble pulse and respiration, sweats and tremors, some or all of which signs of fear the severer cases manifest. As these dreams cease to disturb sleep, so these manifestations of fear tend to pass off and give place to the sweet unconscious quiet of the mind. Occasionally during the waking state contemplation of the horrors seen provokes hallucinations or illusions which may lead to motor delirium or insane conduct. A number of striking illustrative cases were given.

Speech defects are a common symptom of "shell shock." Of these mutism is the most common; it may be associated with deafness. Unable to laugh or cough sonorously, to whistle, or to whisper, indeed, to produce any audible sound, mutes are able nevertheless to express their silent thoughts by writing. The cause of the muteness is due to loss of power of phonation. Major Mott discussed this subject very fully in a paper read before the Society of English Singers.[3] Besides mutism and aphonia, stuttering and stammering are not uncommon conditions. There is no difference between the mutism and aphonia met with in "shell shock" and that of hysteria; the manner in which it disappears is similar; even a trivial circumstance, in which attention is taken off its guard and the mute is surprised by an emotional shock, may cause the patient suddenly to speak.

A very interesting case was narrated of a grenadier who, when admitted, was blind, deaf, and mute; he was, however, extremely sensitive to skin impressions; indeed, it seemed as if the mind focused attention on the perceptual avenue which had not been functionally dissociated by the shock. His sight was restored to him quite suddenly, and he was then able to communicate his silent thoughts by writing. His power of recognition was good, but his recollection was a blank for the whole period of time he had been in France, and he could give no information regarding the circumstances which led to the condition he was in. A few days later he became very emotional, and suddenly recovered his hearing and speech.

Although mutes are unable to speak voluntarily, yet under the influence of terrifying dreams they often call out in their sleep. One man had been shouting in his sleep and was told this the next morning by a comrade; he was so surprised that he said, "I don't believe it."

Various functional paralyses are common, and an injury often determines the seat of the paralysis by suggestion; thus a man may be blown up and bruised on his hip or shoulder, and a fixed idea is engendered that the limb is paralysed. Functional paralysis of the lower extremities in consequence of injury of the back is a common condition; likewise various disorders of gait and station, tremors, coarse and fine, tics, and choreiform movements are other manifestations of motor functional disorders. Hyperæsthesia, or increased sensibility of the skin to stimuli, and anæsthesia are of frequent occurrence. One of the commonest and most troublesome symptoms is hyperacusis, or sensitiveness to noises; and when the Zeppelin raid occurred many serious relapses took place. It would take too long to detail the manifold symptoms that may arise in consequence of these functional neuroses.

Major Mott does not employ hypnosis or psychoanalysis; he considers these modes of treatment unnecessary, as he has cured numbers of cases by making a careful examination of the patient, and then assuring the paralysed, the tremulous, the mutes, and others that there is no organic disease, and that they will certainly recover. An atmosphere of cure is necessary; therefore when a patient with functional paralysis comes with crutches or sticks, the first thing he does is to order them to be taken away, for they are not required. Many men who had been paralysed weeks and months have thus been cured in a few hours or a few days. Massage and electricity, and all other treatment which suggests a disease, he deprecates. He strongly advocates diversion of the mind from the recollection of the late terrifying experiences by music, games, and amusements of all kinds, and he appealed to the charitable public to provide such for the new Maudsley Hospital of the London County Council, Denmark Hill, which has been recently taken over by the War Office for the treatment of 200 of such cases as those to which he referred.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Special Board for Biology and Geology have made the following grants from the Gordon Wigan Fund:—30*l*. to the Department of Geology towards meeting the deficit in the working of the department; 40*l*. to the Department of Botany for assistance to the curator of the herbarium in his work on the British flora; 30*l*. to Prof. Punnett, in order that the Botanic Garden Syndicate may continue to offer special facilities for plant-breeding experiments; 5*l*. to the curator in entomology for the care and development of the collections of insects; 15*l*. to Prof. Gardner for the provision of special lectures in parasitology in connection with the diagnosis of disease.

THE council of the Teachers' Guild has arranged for a conference on educational reform, to be held on Saturday, April 8. Specialists in various grades of education—university, technical, secondary, and

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[3] "The Psychic Mechanism of the Voice in Relation to the Emotions." *Brit. Med Journal*, December 15, 1915.